I found a variegated *Carya* by walking the rows at the Vallonia Indiana State nursery where they grow about 5 million seedling trees every year. It is now planted at Bowman Springs in Seneca Park in Louisville.

In this golden era of plant exploration, it seems that horticulturists are examining the natural beauty in every corner of the world, but we should remember to appreciate and plant our grand natives that lived here for centuries before us — the great bur oaks, *Q. macrocarpa*, that dominated Kentucky's bluegrass savannas; swamp chestnut oaks, *Q. michauxii*, growing in the lowlands of the Ohio River near Fort Knox; blue ash *Fraxinus quadrangulata*; chinkapin oak *Q. muehlenbergii*; and white oak *Q. alba*.

Let's also remember the plantsmen in our own backyards — people like Buddy Hubbuch, Gary Lanham, Dave Fleming, and Theodore Klein. They were kind and generous souls whose greatest joy was to give away their plants.

Seed Propagation — The Lost Art©

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INTRODUCTION

We at WE-DU Nurseries grow several thousand different plant types that necessitates a wide range of propagation techniques. We grow over 50% of these plants from seed, most of which were collected from our own stock. Of our seed-propagated plants, 60% to 75% are native to the eastern United States. Our main reason for growing from seed is to promote genetic diversity in the species and to produce plants not commonly offered in the trade.

Our native phlox, lobelia, asters, azaleas, and others offer great opportunities for selecting superior and unique cultivars from wild-collected seed. *Trillium*, *Helonia*, *Chamaelirium*, and *Cymophyllus* are good examples of plants not readily available in the commercial trade. We must produce the seed of these plants to use in our finish production facilities.

Current commercial seed production has allowed thousands of species to be available for growers. In perennials especially, many species have become available through many seed houses. Along with the proliferation of seed species available, plug production grew dramatically in the last 20 years causing fewer nurseries to grow and produce their own seed. This change in commercial production has lead veteran growers to view seed propagation as a "lost art".

One of the problems of seed production of unusual species is the lack of good reference material. Norm Deno has produced some data on many obscure plants. Books by Dick Bir on native trees, Jan Midgley on Southeastern native wildflowers, William Cullina on native wildflowers among others have given some light to these topics. Not only growing these rare plants from seed, but production and harvesting the seed presents a great challenge.

SEED STOCK PRODUCTION

Producing seed for harvest requires more than simple collection of mature seed from the production blocks. Many species will cross pollinate if grown too close to related plants. This means creating stock blocks with similar species far apart from one another. This is the only way to guarantee that the species remains true. Stock beds may be clustered together, but planning of bloom times is essential for success. This is one of the most efficient and easiest to control methods of using stock blocks.

The landscape offers a great opportunity to mingle different species for use as a stock block. Maintenance is fairly low and allows easy access to plants which may require several visits per season to harvest all of the seed. A good example is *Silene virginica* whose seed ripens intermittently over a 3- to 4-week period.

Water and bog plants have become very popular and natural ponds provide good seed stock areas. Small man-made ponds provide a less-complicated means of growing and collecting seed. *Thalia dealbata,* Louisiana iris, *Orontium aquaticum,* and pitcher plants are but a few of the natives that are easily grown in these types of artificial ponds.

Collecting from managed wild colonies (wildcrafting) is an excellent method of producing seed. By taking an established colony and removing competition, the colony can produce commercial quantities of seed while continuing to flourish. By removing competition we mean removing other vegetation or limbing-up trees for better sun exposure.

Collecting from the wild responsibly is a highly desirable method of obtaining native seeds. One is able to add genetic diversity into a species that may be suffering from over-propagation of a particular species. We utilize the areas near us to collect our wild seed. These include:

- Logging trails. These remain for many years and offer a wide population of both sun and shade plant types.
- National forest. We work with wildlife botanists to evaluate potential species that are garden worthy.
- Power Lines. Large diverse areas with numerous native plant species.
- Rivers. River banks and streams along valley floors offer a unique group of plants of great garden value.

SEED HARVEST

The harvest of seed begins in mid-spring as plants such as *Sanguinaria canadensis* must have their seed sown just after ripening. Seed collection continues all summer and fall with members of the composite family and many woody plants being the last to mature. If missed at the appropriate time of year many seeds remain intact and viable on the plant into winter. These can be collected and processed as with other seeds.

The collection process ranges from extremely easy to frustratingly difficult. The easy seeds to collect ripen all at one time and remain intact on the plant. Others ripen intermittently over an extended period requiring multiple trips to collect. Then there are those that disperse seed by an exploding seed capsule. If you are not there to collect on the “right” day, the seed is lost. We use seed bags to cover the ripening seed heads of these types to ensure we do not miss the release. This allows for more flexibility in collecting a particular seed. Some plants need support when fitting the collection bags to avoid breaking fragile stems and to keep the bags from resting on the ground where excessive moisture may cause a problem.

Many times it is not practical to return to a plant to collect the seed at the “ideal” time, especially from a wild colony. Some seed will continue to mature in the pod even if collected before its optimum time. We also place stems with immature seed pods attached in a pot in the greenhouse where they can be harvested when ripe.

Harvested seed is kept in paper bags or envelopes to air dry after being picked. They are kept in a well ventilated room with temperatures ranging from 55°F to 75°F. They are kept here for a couple of weeks up to a month or more before they are processed. The next step is to inventory all the seed to determine its germination needs. Many seeds need long periods to cure and need to be cleaned first to get them in the schedule so that they are able to come out of the curing process to be planted in the most efficient time manner possible.

The next step in the process is to clean the seed; that is, to remove from it the outer covering such as a hull or pulp. Many seed offer difficult challenges if not performed carefully. Milkweed (*Asclepias syriaca*), for example, can entirely fill a room with silk fluff if not properly handled. Other seeds have hard coats, difficult to break open, and some are so small one must use a magnifying glass to work with them. Many times after drying, the seed has reached optimal ripening in the storage bag and has spontaneously dislodged from its hull sufficiently to only require separation from the chaff.

We use several methods and tools to clean our seed. The use of sieves to filter the seeds through larger to smaller sets of screens works well on a wide variety of different seed species. Care must be taken as to not harm the seed when forcing it through the screen openings. A food mill, blender, rolling pin and other food processing equipment all work well in cleaning different types of seed. Many times cleaning can be done in the field. Large amounts of seed can be cleaned by businesses with commercial seed-cleaning equipment. Several, such as the Brandywine Conservatory can clean seed on a “per job” basis. Fleshy covered seed can be soaked in water to soften the pulp, passed through a food mill, and washed and dried to process. We have also used a blender to remove the fleshy covering from seed.

Cleaned seed is dried if needed and placed in a paper envelope for storage. Some seed requiring cold stratification is packed in damp — not wet — play sand. Some seed that needs to be kept moist is packed in vermiculite and stored in a plastic bag.

Once the seed is placed in either a bag or envelope and marked for identification, and depending upon its requirements for germination, it is stored accordingly. Others are placed in a refrigerator at 40°F for several weeks up to several years. We have had good success in keeping most seed in cold, dark storage for several years.

Hydrophilic seed that are ripened in a fruit or berry capsule and are moist when cleaned should be stored in moist vermiculite in a plastic bag. Some examples are *Dicentra cucullaria*, *Clintonia umbellata*, *Trillium* species, and *Caulophyllum thalictroides*. If the seed are dry when cleaned, they do not require storage in moisture. Some examples are *Spigelia marilandica* and *Cymophyllus fraserianus*.

SEED GERMINATION

Seed germination has several major requirements: moisture, optimum temperature, oxygen, and light.

Moisture. We use a mist irrigation system similar to that used for softwood cutting propagation. The mist nozzles we use output 3 $gal \cdot min^{-1}$. We also use hand misting nozzles with an output of ½ and 1 $gal \cdot min^{-1}$ as well as the 1000 hole water breaker (Redhead by Dramm).

Temperature. Below bench heat allows for multiple ranges of germination temperatures to be used. Plastic cover tents inside the greenhouse allow us to control the temperature of a specific bench with in a house. Seed needing cold stratification is put in a cooler at 40°F for the desired time period. We find that many winters we can not get the number of cold units needed to stimulate germination so all cold stratification is done artificially.

Oxygen. We use medium grade chicken grit (crushed granite) to top dress all our seed flats except those that are fast and easy germinating. The grit allows excellent oxygen exchange while shading the sowing surface. It also helps retain moisture and inhibits the formation of moss. Moss can be a difficult problem on seed taking more than 1 year to germinate.

Light. Many plants need light in order to germinate and must be sown directly on the surface of the soil with no covering. We may use chicken grit to cover the surface of the soil, but we spread the chicken grit on the surface of the soil first, then sow the seed. Our rule of thumb is that any seed smaller than a grain of salt is surface sown.

METHODS OF SOWING THE SEED INCLUDE

Using a Custom Dibble Board. These dibble boards use different spacing between rows to allow for different types and sizes of plants. The flats sown with dibble board spacing allow more flexibility in handling a wider number of different plant species.

Sowing into Outdoor Beds. Seeds such as *Trillium*, *Sanguinaria,* and other spring ephemeral plants respond best to the whims of mother nature controlling the variables. Other examples are *Asarum*, *Hepatica,* and *Anemonella thalictroides*.

Sowing Directly into Salable Pots. This can be done in late spring using reliable seed species that germinate quickly and consistently. This is a very labor-saving method in the nursery.

Sowing into Plugs. This is commonly done in the industry.

Sowing into Shallow Pots. Done for small quantities of seed that would not fill a flat.

Hot Water Soak. This method requires a couple of extra steps of seed preparation before sowing. The seed must be soaked in hot, almost — but not — boiling water for 24 h. They may then be dried and sown. We have excellent success using this method for *Baptisia, Hibiscus, Callirhoe,* and legumes.

Moss Germinating. Plants like *Houstonia* can be planted into a flat of moss in the spring and left to drop its seed into the flat. Young plants can be plucked out mid spring of the following year. Other plants responding well with this method are *Galax, Shortia,* and *Rhododendron*.

Fire-dependant Germinators. Recent research suggests that many plant species that were difficult to germinate respond markedly to being fumigated by or exposed to smoke produced by burning grasses, wood chips, or even paper. A smoker used by bee keepers using grasses like broom sedge or little bluestem seem to be a favorable way of producing smoke.

In closing, good cultural practices are essential to successful seed propagation. The recent invention of the HAV fans in the propagation house have greatly reduced disease pressure. This is one good example of many simple ideas that can be utilized in the "art" of seed propagation.

Status of the Commercial Micropropagation Industry©

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In 1996, a comprehensive survey was made of U.S. commercial micropropagation laboratories to determine the extent of the industry (Zimmerman, 1996). Industry interest in the results of this survey prompted us to update the information with a new survey, which was started in 2000 and completed in 2001. As in the previous survey, data were collected by doing telephone interviews with the owner or manager of each laboratory.

To maintain confidentiality of production figures, we grouped labs into 5 areas as follows: (1) Florida, (2) California and Hawaii, (3) Oregon and Washington, (4) Eastern U.S. (all states east of the Mississippi River except Florida) and (5) West-Central U.S. (all states west of the Mississippi River except those in (3) and (4) above). Similarly, we grouped crops produced into the following categories: (a) foliage plants, (b) greenhouse flowers and orchids, (c) herbaceous perennials and annuals, (d) trees and shrubs, (e) vegetables, (f) fruits and (g) miscellaneous crops.

A total of 93 commercial micropropagation laboratories are currently active in 28 states, down from 111 in 1996, and most still are located near important production areas of the horticultural industries they serve. Florida and California continue to have the most labs (13 each). Other states leading in numbers of labs are Colorado (7), Connecticut (7), Montana (5), Oregon (5) and Washington (7). The remaining states have four or fewer labs, with 13 states having only one lab. Of the total, 79 labs were active in both surveys, 32 from the earlier survey are no longer active and 14 new ones have opened.

Laboratory production varied from a few thousand units to more than 10 million units per year. We categorized the laboratories (in units per year) as small (<500,000), medium (500,000-2,500,000), large (2,500,000-6,000,000) and very large (>6,000,000). Small labs totaled 54 with 19 producing fewer than 50,000 units per year. The remaining labs were 27 medium, 5 large, and 7 very large. Very large labs account for 58% of the total production, large labs for 14%, medium labs for 23%, and small labs for only 6%.

Total production for 2000 was 130,613,000 units (shoots, plants, bulbs, mini-tubers), up from 120,862,000 units in 1996. Foliage plants (ferns, *Spathiphyllum*, *Syngonium*, *Dieffenbachia*, *Ficus*, *Calathea*, *Philodendron* and many other genera) are the largest category at 63,102,000 plants, down about 1% from 1996. Trees and shrubs (including ericaceous plants) were the next largest category with production of 21,550,000 plants, up 41% from 1996. Ericaceous species (azalea, *Rhododendron*, *Kalmia*, *Pieris*, *Leucothoe*) now account for 30% of the total, shrubs (e.g., *Nandina*, *Syringa*, *Fothergilla*, *Hydrangea*, *Photinia*, *Viburnum*, and many other genera) are

[1]Retired